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Fern Rusts of Hawai'i

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Rust fungi comprise a rather homogeneous group of highly specialized obligate plant parasites. Rusts are usually characterized as being host specific, with the specific identity closely correlated with the host species itself. Phylogeny of rust fungi as a group is likewise thought to follow that of their hosts, all of which are vascular plants (i.e., ferns, conifers and angiosperms, both monocots and dicots). However, rusts are also characterized by life cycles which contain up to five different types of spores. In heteroecious species, two completely unrelated types of host plants (e.g., an angiosperm and a gymnosperm) are needed to complete the life cycle, whereas in autoecious species all spore states are produced on a single host species. The most primitive rust fungi are thought to be those that produce the telial spore state on ferns and the aecial state on firs (*Abies* spp.). Among these, the genus *Uredinopsis* usually is considered to be the most primitive of all known rust genera (Cummins and Hiratsuka, 1983). Whereas most rusts are variously pigmented in shades ranging from dark brown to orange to yellow (giving infected plants the superficial appearance of iron rust, hence the name), species of *Uredinopsis* are unique in being completely devoid of pigmentation, a further indication of their primitive status. The spore masses therefore appear white.

A species of *Uredinopsis* occurs in Hawai'i on bracken fern. This fern previously was referred to as *Pteridium aquilinum*, the

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bracken of worldwide distribution. Recently, however, the Hawaiian bracken has been recognized as an endemic subspecies (*P. aquilinum* subsp. *decompositum*), or has been elevated to endemic species status distinct from *P. aquilinum* as *P. decompositum* (Valier, 1995; H. Wagner, personal communication). The rust appears confined to the lower surfaces of fronds and is apparent, particularly when viewed with a lens, as masses of white spores emerging from ruptured fruiting bodies, or uredinia. This rust was first reported from Hawai'i in 1938 on bracken, then recognized as *P. aquilinum* var. *lanuginsum* (Faull, 1938), and was discussed later by Gardner and Hodges (1989) as being apparently rare in the islands. However, in subsequent observations in the Mauna Loa strip area of Hawai'i Volcanoes National Park, the fungus was locally common, but apparently is seasonal in occurrence (Gardner, in press). Its occurrence in Hawai'i wherever the host is found would not be surprising. Whereas most rusts are identified on the basis of the morphology of the teliospores, the urediniospores of *Uredinopsis* provide what may be the only reliable criteria for separation of species (Ziller, 1959).

The binomials *U. pteridis, U. hashiokai,* and *U. aspera* all have been used variously to refer to bracken fern rust in Hawai'i (Raabe et al., 1981). However, *U. aspera* has been placed in synonymy with *U. hashiokai.* The arrangement of projections (or "cogs") on the spore surface, whether arranged in definite rows or randomly scattered, is useful in distinguishing between *U. hashiokai* and *U. pteridis*, as is the presence or absence of amphispores (a type of morphologically specialized urediniospore). The white-spored rust of bracken fern examined thus far in Hawai'i produces urediniospores with irregular, randomly distributed cogs and lacks amphispores, and is therefore considered *U. hashiokai* (Gardner, 1994).

As indicated above, fir trees are known as the alternate hosts of *Uredinopsis*, upon which the spermogonial and aecial spores are produced. The rust, particularly *U. pteridis*, can cause significant economic damage to fir trees in Western North America (Ziller, 1959). Since fir does not occur in Hawai'i, *U. hashiokai* is thought to survive by undergoing an abbreviated life cycle in which the urediniospores are capable of reinfecting the fern host and perpetuating the rust, thereby foregoing the normal long-cycled, sexual life cycle. In this way, it is possible that the rust in Hawai'i, because of its isolation, may have developed a degree of genetic divergence from its mainland counterpart, although this has not been experimentally shown.

The second of the two currently known fern rusts in Hawai'i was discovered by a plant rust expert, Dr. Roger Peterson, while visiting Kaua'i in 1991. Dr. Peterson collected a small section of a pai'i'iha [*Christella* (=*Thelypteris*) *dentata*] (Valier, 1995) frond which had a few urediniospores of what he suggested may represent a species of *Hyalopsora.* The genus *Hyalopsora*, like *Uredinopsis*, is considered primitive, but is characterized by yellow pigmentation, although sometimes faint, of the spore contents. Dr. Peterson's scant collection remained unconfirmed and tentative until April, 1996, when one of us (TF), with David Lorence of the National Tropical Botanical Garden, found a stand of pai'i'iha on Kaua'i so heavily infected with the new rust that infected fronds took on a yellowish cast due to the masses of bright yellow spores. The rust was found in the Waimea District, Ku'ia Natural Area Reserve, Mahanaloa Valley below the trail from Miloli'i Ridge to Ku'ia Valley. The abundance of the rust at this site, together with the fact that the host is widespread in Hawai'i, indicates that this species, like *Uredinopsis*, is not as uncommon as was earlier thought. Collections were deposited at B. P. Bishop Museum (BISH 644615) as *Hyalopsora* sp. Attempts to key the fungus to species under *Hyalopsora* were not satisfactory, and the rust was sent to Dr. Joe Hennen, recently retired as curator of the Arthur Herbarium of Rust Fungi at Purdue University (PUR), for assistance in identification. Dr. Hennen recognized the rust as *Desmella*, a genus currently known to contain a single species, *D. aneimiae*, which he had previously collected in the Amazon region of Brazil. *Desmella* is an incompletely understood genus whose life cycle, whether heteroecious or autoecious, is not known (Cummins and Hiratsuka, 1983). This rust is characterized by production of yellow pigmentation in the urediniospore wall, as well as in the spore contents. It is unique in being limited in development to substomatal chambers of the host leaf tissue, rather than producing

extensive intercellular mycelium as in most rusts. Urediniospores and teliospores (the latter not yet known from Hawai'i) of *D. aneimiae* are borne on pedicels (stalks) emerging from stomates, giving the appearance of discrete spore clusters on the undersurfaces of infected fronds when examined with a lens.

Microorganisms, including fungi, are dispersed relatively unnoticed, making the question of their indigenousness somewhat more difficult than that among higher life forms. The host specificity among rust fungi, however, permits some meaningful speculation as to the origins of members of this group. Gardner (1994) listed *U. hashiokai* as being possibly indigenous to Hawai'i, an argument now supported by recent recognition of its host as endemic. On the other hand, the establishment of a rather definite date (1887) of probable introduction to Hawai'i of pai'i'iha (Valier, 1995) suggests that *D. aneimiae* most likely was introduced with its host, probably from the Neotropics (J. Hennen, personal communication), and would therefore not be considered native.

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The Phenology and Growth Rates of the Weed Gorse (*Ulex Europaeus*) in Hawai'i

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Gorse (*Ulex europaeus* L.; Leguminosae) is a leafless, spiny, multi-branched shrub native to western Europe, where it extends from Scotland, south to Portugal, and to northern Morocco in Africa (Zwolfer 1965). In the 18th and 19th centuries, young foliage was considered high quality grazing for sheep, and mature plants were valued as hedge to contain animals (Jobson and Thomas 1964). As a result, gorse was spread all over the world. Where gorse was deliberately introduced, it escaped cultivation, and today is a major weed in more than 15 countries or island groups, including New Zealand, Chile, Tasmania, Brazil, and, in the United States, the west coast of Oregon, northern California, and Hawai'i (Holm et al. 1974). In Hawai'i, gorse is restricted to the islands of Hawai'i and Maui (Markin et al. 1988), where it is an aggressive invader of pasture lands, rendering them unsuitable for grazing. Gorse has also invaded native Hawai'i shrub lands and open native forests where it competes and replaces native species, which increases incidence of wildfire due to gorse's extreme flammability.

Gorse has long been recognized as an aggressive invader in Hawai'i and been targeted for control by the Hawai'i Department of Agriculture, the Department of Lands and Natural Resources, and private landowners. Control programs have successfully slowed the further spread of gorse, but despite several attempts at elimination or eradication with herbicides, gorse remains well-established and vigorous in core areas due to the large seed bank in the soil. Gorse seeds are notorious for lying dormant in the soil for years, then regenerating following herbicide treatment or burning (Moss 1959).

Biological control of gorse in Hawai'i (Markin and Yoshioka 1989) was unsuccessfully attempted in 1926. In the 1950s, another program successfully established a seed feeding weevil, *Apion ulicis*. In 1984, a new cooperative program aimed at developing long-term management strategies for gorse was begun by various resource management agencies and private landowners. A major component of this program was a new effort at biological control with the goal of releasing and establishing five new control agents (Yoshioka et al. 1991). In preparing the program, we realized that despite gorse's status as a weed in Hawai'i for over 70 years, nothing was known about its basic biology. In planning our new biological control program, information on two features of this plant's biology, its phenology and growth rate, were deemed critical. An accurate knowledge of a plant's phenology is necessary for planning the release of new biological control agents so their life cycles synchronize with the proper plant stage. The knowledge is also useful for designing post-release sampling to determine the agents' presence and impact.

The agents targeted for release in the new gorse program were all defoliators that fed on either the new shoots growing in summer or on the older, harder spines during the rest of the year. Even if successful, we expected that this agent complex would not immediately kill the plants, but would stress them over a long period. To measure this impact, some indicator of plant vigor was needed. The most obvious and simple method was to record the plant's growth rate before the insects were released and

* Retired

after the complex was well-established and then compare the data.

In 1984, with the initiation of the new biological control program, an effort was undertaken to determine both the phenology of gorse and its yearly growth rate. This information and some general observations on the biology of gorse in Hawai'i is presented.

Research Areas

Island of Hawai'i. The gorse infestation is limited to approximately 8,000 ha. on the south and east slopes of Mauna Kea extending from Saddle Road (Highway 20) as the westernmost point, eastward along the Keanakolu Road for approximately 11 km in a crescent shape following the 1,800 m (6000 ft) elevation contour (Markin et al. 1988). Ten study sites approximately 1 km apart were selected on either side of Keanakolu Road; all sites were at least 100 from the road. The westernmost point of the infestation lies on the edge of the Mauna Kea rain shadow, which during nine years of observation, received approximately 90 cm of rainfall annually (range 50-100 cm). The other extreme on the east slope of Mauna Kea received approximately 190 cm of rainfall annually (range 125-250 cm). Most land infested by gorse belongs to the Hawaiian Home Lands and was leased to Parker Ranch. Two other ranches and the US Fish and Wildlife Service's Hakalau Bird Refuge also contain infestations.

Island of Maui. Two major concentrations of gorse are found within the 6,000 ha. of infestation on Maui (Markin et al. 1988). The upper area consists of scattered patches between 1,800 and 2,100 m (6,000 and 7,000 ft) on Haleakalā National Park and adjacent lands of Haleakalā Ranch and Nature Conservancy on the north slope of Haleakalā. Most of this infestation is above the pasture lands in the pukiawe shrub zone. The area is relatively dry; Park Headquarters, adjacent to the major areas of infestation, receives approximately 150 cm of rainfall a year. The three study sites selected were all inside Haleakalā National Park. The second major gorse stand on Maui surrounds the old Olinda prison facility above the community of Makawao. Four plots within a 2 km radius of this state facility, located at elevations of 1,000 to 1,100 m (3,300 to 3,600 ft), were selected on private and state lands. This area is highly urbanized, with gorse scattered on vacant lots between private homes and located in forest understory of introduced pines and *Eucalyptus*. The area is the wettest locality where gorse has been found in Hawai'i; the Olinda facility receives approximately 400 cm of rain annually.

Methods and Materials

The oldest and most continuous phenology record we have on gorse is that of its flowering period, which is based on monthly photos taken at six of the ten study sites on Mauna Kea. The photos were taken at pre-established photo points and were marked by stakes at the positions where the photos were taken, facing a line or wall of gorse plants approximately 10 m away; a pole or flagging ribbon denoted the center of the photographs. Photographs were taken using 35 mm color slides and were projected on a 15 X 20 cm screen of a table top viewer in the laboratory. The screen was overlaid with a clear plastic sheet marked by a 1 cm grid of inked lines. The total number of squares falling on gorse plants in the image was counted and the percentage showing recognizable yellow, indicating the presence of flowers, was determined.

The photo records at these six established study sites not only indicated the period of flowering, but also provided a permanent record of the change of the gorse cover size and density. Over the years, the photo points occasionally were shifted as the gorse density increased and prevented access to the sites or obstructed visibility of the selected plants. New photo points were selected in the immediate area, so, despite some gaps due to personnel changes, a relatively complete record was compiled over a 10-year period (1984-1993). No photo record was made on Maui.

Using photo points did not allow us to record less visible changes in the plants, i.e., the occurrence of buds, seed pods, growth of new shoots, etc., which was a major advantage. For a more quantitative reading, ten plants at each sample site were randomly selected, and a single lateral branch was chosen and tagged. These branches were re-examined monthly to determine the presence or absence of flowers, pods, and actively growing shoots. These readings were made in 1987 and 1988 as well as in 1992 and 1993 at all ten sites on Hawai'i and all seven sites on Maui.

To determine the growth rate of gorse plants at each study site, ten new shoots, each growing from a separate tagged branch, were

chosen in early spring and were marked while still less than 2 cm long. These shoots were observed in the summer while they were growing, and in fall, when that year's elongation had finished and the shoot had hardened, their lengths were measured. These data were recorded for both Hawai'i and Maui, but the Maui data was lost during a change in personnel.

RESULTS

Flower Phenology. Flowering was intensely observed on Mauna Kea, where we have visited the ten study sites almost weekly from 1984 to 1993, mostly to release and monitor biocontrol agents. We observed that flower buds form only on the current season's (summer's) new growth, after it has hardened in fall. Buds were first noticed as pairs of fuzzy, white ovals, 1 to 2 mm in diameter, at the base of secondary spines, which branch off the main spines. Except at the tip, flower buds are not found on the main stem of the branch. Buds remain inactive after forming for four to six months during the fall and early winter, and begin to swell approximately one month before opening.

The flower is pea-like, approximately 2 mm long, and bright yellow with a distinct keel containing the stamens and stigma. Flowering on different branches of an individual plant is usually highly synchronized, although flowering between adjacent plants can differ by as much as three or four months. On an individual branch, flowers may occur simultaneously, randomly scattered over the branch, or form a band that begins at the base of the branch (the oldest part of the branch that was the first to harden during the previous summer) then moves outward over two to three months to the branch tip. A single branch that is 50 cm long can produce 500 to 1,000 flowers over a two- or three-month flowering period. If an individual flower is not pollinated, it aborts in three to four days.

Flowers are not self-pollinating, and require a large insect to probe the keel base for nectar. This probing trips the mechanisms that open the keels and release the stamens and stigmas. On release, these parts spring up and strike the insect on its ventral surface, depositing new pollen and removing foreign pollen. On Mauna Kea, the only insect observed pollinating gorse was the feral honey bee. Bee populations are limited on Mauna Kea, probably by the shortage of suitable nesting sites in hollow koa trees, and during peak bloom, their numbers are overwhelmed by the huge volume of flowers. At the core of the main infestation, less than 1 percent of the flowers are pollinated to produce pods. However, at the periphery, where the bees from the surrounding area concentrate, a pollination rate of 50-90 percent occurs.

On Mauna Kea, a few plants can be found flowering all year round, but during the summer, the occurrence of flowers may be as low as a few plants per hectare. Flowering begins in October and November and increases steadily to a peak during January, February, and March. The high number of flowers produced per plant and the dense stands of gorse that occur in the central 2,000 ha. of the infestation on Mauna Kea often produce an intense blanket of yellow visible from several miles away on Saddle Road (Highway 20). Flowering then declines during spring and reaches the summer low beginning in June (Fig. 1).

On Maui, the flowering pattern differs slightly (Fig. 2). On Haleakalā, flowering begins around the same time as on Mauna Kea, but it peaks in December and then declines rapidly. This results in a shorter flowering period (six months) that ends approximately two months before it does on Mauna Kea. At the lower elevation site in Olinda, flowering was similar to Mauna Kea, but began nearly two months earlier.

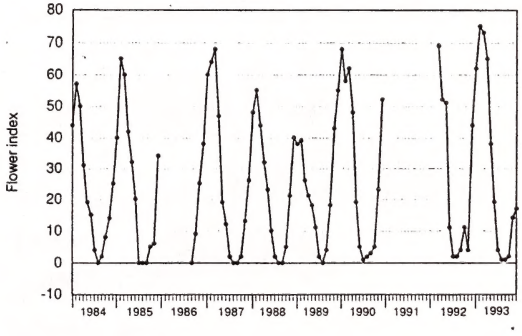

Fig. 1. Seasonal flowering of gorse measured from monthly photographs taken at six sites on Mauna Kea. Blanks represent missing data.

Pods. Successfully pollinated flowers adhere tightly to the plant but shrivel and dry. The developing pods form within this dried flower and within two weeks grow up to 1 cm. In a month, the new pod, which is green and succulent, is almost full-sized, and it protrudes from the tips of the dried flower. Pods require a second month to completely mature, at which time they are black, dry, and hard, so the peak period of mature pod abundance begins around two months after peak flower abundance (Fig. 2). On Mauna Kea, the percentage of branches observed containing mature pods is less than the number of branches found earlier containing flowers, probably due to a lack of pollinators.

Pods are approximately 1.5 cm long, and they typically contain four or five (range 1 to 12) hard, round, greenish-gray to dark brown seeds, 1.5 to 2 mm in diameter. A noticeable feature of the free seeds is that they contain an irregular-shaped yellow structure at the base, an elaiosome — a fleshy appendage rich in oils and proteins which attract ants that, in the gorse homeland in Europe, function as seed dispersers (Weiss 1909; Pemberton and Irving 1990). No ants were associated with gorse on Mauna Kea. On Haleakalā, the only associated ant was the Argentine ant (*Iridomyrmex humilis*), which might feed on the elaiosome but is probably too small to disperse the seeds. In Hawai'i, elaiosomes most likely do not play a significant role in seed dispersal.

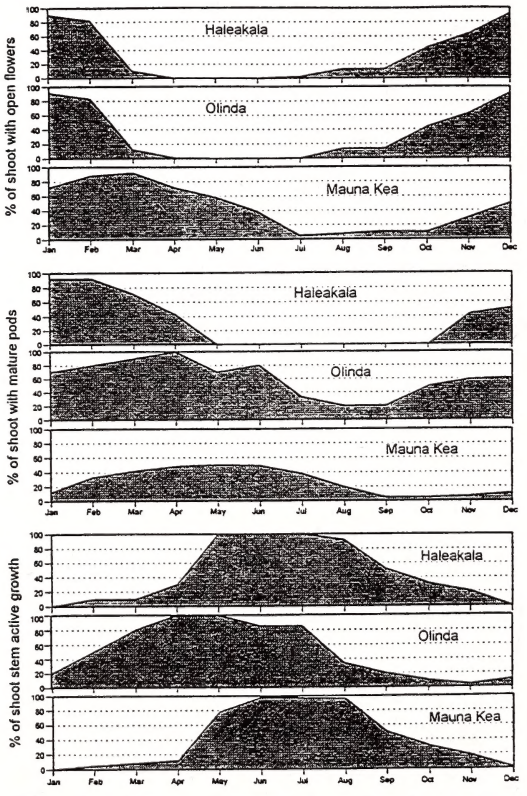

Fig. 2. Percent of gorse plants found containing flowers, mature pods, or actively growing new shoots. Data is average of four years of observations (1987, 1988, 1992, 1993).

On dry, sunny, warm days in late spring and early summer, the mature pods on the plant split, and the two halves violently twist, throwing the seeds outward 1 to 3 m (dehiscing). While long distance spread in Hawai'i occurs almost entirely by man or cattle accidentally moving seeds or by water carrying them down drainages, short-distance spread (plants slowly expanding into a new area), however, occurs by self-dispersal through dehiscing.

Gorse seed germination in Hawai'i was not investigated, but in the literature, the seeds are notorious for their long life span in the soil. Reports of seeds remaining viable in the soil for hundreds of years are questionable, although one attempt to investigate the phenomena in pasture lands in New Zealand indicated that over 25 years is possible (Moss 1959). In New Zealand, researchers estimated that 10,000 seeds/m^2 can be found in the soil undermature stands (Ivens 1978).

Vegetative Growth. On Mauna Kea, the vegetative buds first appear in late winter, usually while the plant is flowering. The majority (85 percent) of the new buds form in the outer 20 cm of the branch (n=50 plants), frequently near the main stem at the base of an old, hard spine. First vegetation buds resemble flower buds, but later when 2 or 3 mm in diameter, they take on a rosetta form with an irregular, lumpy surface. At higher elevations, bud swelling begins in February and March, and new growth begins in April and May while flowers and unopened pods are still on the branch. The developing shoots contain a rounded, soft, succulent tip consisting of the developing soft spines. As the shoot elongates, the new spines lengthen and harden. Eventually, as the summer progresses, the spines at the new branch's base are fully mature

Table 1. Yearly growth of 100 new gorse shoots on Mauna Kea.

Year	Approx. Size of Plant	Elongation (all shoots) (x ± SE)†	Elongation (longest shoots*) (x ± SE)†
1987	1 m	27.9 ± 1.3 cm	49.6 ± 2.0 cm
1988	1.5 m	18.2 ± 2.2 cm	26.2 ± 2.1 cm
1992	2 m	31.9 ± 2.4 cm	47.3 ± 3.3 cm
1993	2 m	16.0 ± 1.8 cm	29.9 ± 3.3 cm

* Growth of plant (size, height, etc.) is not determined by average shoot elongation, but by the longest shoot on the terminal of each branch. This figure reports the average of the ten longest shoot measurements at each of the ten sites. Therefore, this figure more accurately reflects the year increase in size of the plant on Mauna Kea than the average elongation.

† x = mean; SE = standard error.

and hard while spines further out on the branch become smaller and softer. Active growth is noticeable during the three months of summer, but it slows down during September. Most plants have hardened (mature branches by October or November), giving a six-month period of active growth Of the plants observed at higher elevations, all had terminated growth by December, although a few plants in the surrounding area, generally immature plants less than two feet high or plants regenerating from cut stumps or coppicing in burned areas, continued to grow during the winter.

The mean number of new shoots a single branch produced was 37 (+3.25 SE) with a range of 7 to 180 (n=100, Mauna Kea's 1988 study). Vegetative buds further down the branch, particularly where shaded, showed the least growth. The average length of all randomly chosen shoots measured over four years ranged from 16 to 32 cm (Table 1). In the terminal end of the branch, usually 3 to 5 buds show the most growth, with average elongation from 25 to 50 cm per year. These longer terminal buds formed the branches that determined the growth, shape, height, diameter, etc. of the plant; the remaining shoots were shaded out and died in a few years.

On Haleakalā in Maui, the period of new shoot growth was similar to that observed on Mauna Kea, but all data on shoot length was lost when a change in technicians occurred. However, as a general observation, the overall length of the year's new growth on Haleakalā was considerably less (possibly even half) of that on Mauna Kea. At the lower elevation near Olinda, the period of new shoot growth was much longer than that at both higher elevation sites, with an active period of growth beginning as early as January and February while active flowering was occurring.

Discussion

Phenology and growth of gorse follow a distinct pattern, at least at the higher elevations in Hawai'i. New vegetative growth occurs during the summer and terminates in the fall. Formation of both vegetative and reproductive buds occurs on these newly formed branches in fall and winter. Approximately two to three months after the termination of new growth and the hardening of new shoots, flowering begins and continues from December through June. Pod formation peaks nearly two months after the flowering peak, reflecting the two months it takes the pods to mature. After flowering and production of new vegetative buds for the following summer, a branch becomes inactive, slowly losing its chlorophyll and spines to become a mature stem and eventually one of the plant's trunks. We never found a branch that produced new flower buds during a second year. However, if a stem or branch was cut back so that the older, gray wood remained, new vegetative buds would readily form and the plant would resprout.

We felt the pattern seen in Hawai'i was unusual because both flowering and new vegetation growth lasted over a six month period during the year. By contrast, in England this pattern is distinctly different (Hill 1982). As in Hawai'i, a few flowers can be found all year round, but their main period of flowering does not begin until March, and it peaks in April and May. By mid-June, the flowering period is over, so it lasts only three months. In England, vegetation buds begin to expand as early as April, but active growth of new shoots begins in mid-June and terminates by late August for a total growth period of only three months. Mean length of these shoots in England are approximately 6 to 7 cm.

Our gorse population in Hawai'i (at higher elevations) begins flowering at least six months earlier and lasts twice as long as those in its homeland of England. Similarly, our period of vegetative growth, which begins at about the same time as in England (April/May), lasts at least twice as long and produces new shoots that are 2.5 to 5 times longer. This extended period of active flower and growth stages in

Hawai'i could adversely affect some potential biological control agents. If an agent has only a single generation a year and a climatically synchronized emergence, the agents would be active only during the early period of flower or vegetative growth and absent during the remainder of the plant's period of activity. If this should occur, gorse in Hawai'i may escape much of the attack of some biocontrol agents .

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***Lipochaeta lavarum* (Gaud.) DC.**

A New Species of Loulu Palm (*Pritchardia*) from O'ahu

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When a prediction turns to fruition, gratification permeates ones self. About forty years ago, I postulated the presence of a new species of loulu (*Pritchardia*) palm from O'ahu at the mid-elevation level in the northern Ko'olau Range. Years of search yielded plants in a distance, but not close enough to make any definitive observationss.

Recently, five of these plants were observed along a rather unfrequented ridge. One bore fruits and the striking part of the observation was that it had a rather diminutive fruit. When collected, it had the smallest fruit of any known Hawaiian loulu palms.

The plant had narrower trunks as compared with other Ko'olau Range *Pritchardia, P. martii*. Unfortunately, vouchers could not be taken because our pole-cutter could not generate enough power on the elongated bending pole. However, a small handful of seeds were extricated from a matured fruiting inflorescence by ramming it with the end of a long, sagging saw blade. The task was not made easy because on e had to climb onto a dead tree and another flimsy looking, but semi-firm, narrow-limbed o'hia lehua tree (*Metrosideros*) amid a howling wind. Fruits were randomly pried loose by a long pole with a saw blade onto a 70° slope littered with debris. Needless to say, the hunt for seeds was quite an adventure.

At least what few fruits were collected are now planted at the Harold L. Lyon Arboretum. It makes us happy to note that there still are new species to be found on O'ahu. At least for *Pritchardia*, it is the first new species found on O'ahu in nearly a century!

Without the help of Dr. Ron Fenstemacher, what few seeds collected would not be available. He was able to catch some in their downward flight quite acrobatically. He also was adept in filtering through humus debris to recover most of the fruits.

***Stenogyne kaalae* Wawra var. *coriacea* Degener & Sherff**

Book Review:

Biogeography: a Hot Topic for an Evolutionary Hot Spot

Hawaiian Biogeography. Evolution on a Hot Spot Archipelago.
Edited by W. L. Wagner and V. A. Funk. 1995. Smithsonian Institution Press, Washington

This book is a long awaited update on the progress made in research on biogeography and species relationships within the Hawaiian flora and fauna since Carlquist's (1980) monumental book on the natural history of the archipelago. The Hawaiian Islands have long been considered a laboratory for the study of evolution. Those familiar with the flora and fauna of the islands will immediately recognize the factors making this so: isolated by over 2000 miles from any other land source (island or continent), climates that vary from coastal to alpine and rainforest to desert in the space of only a few miles, and an active volcanic rift zone that is adding new substrate in a manner such that the islands are chronologically arranged and their ages can be accurately determined.

There are two components of this book that make it a significant contribution toward Hawaiian biogeography. First, contributors represent the authorities in their respective fields, in some cases reflecting research that has been ongoing for over 30 years (Ch. 5). The topics covered also represent research that has come to be synonymous with Hawaiian evolutionary biology: Hawaiian *Drosophila*, honeycreepers, and the Silversword Alliance to name a few. The second component is the tools that have become available with which to study systematics and biogeography. Cladistic approaches to determining species relationships provide a clear assessment of the movement of species among the islands and biogeographic patterns that can be established. Several studies also use cladistic analysis in conjunctions with molecular analysis of DNA. The speed and ease of accumulating molecular data and the power with which this information can be used to interpret relationships among species and their distribution has revolutionized systematic biology in the past 10 years, and is clearly evident here.

The book consists of four distinct sections. The introduction written by Carlquist (Ch. 1) can be considered either as a prologue of what the intent of the book is to be, or an epilogue summarizing the salient features of the various chapters. In drawing upon his vast experience in the study the Hawaiian flora and fauna, he advocates hypotheses concerning the evolution of Hawaiian species, some of which may never truly be addressable and others leaving the door open for future research.

The discussion on the origin of the islands and species evolution in the developing archipelago (Ch. 2) by Carson and Clague provide an insightful view of the geology from a biological perspective. They point out not only that geographic isolation of the islands accounts for the high degree of endemism found here, but also that geologic isolation on a smaller scale (separation of the islands themselves, distinct mountain ranges within islands, sharp ridge mountains, etc.) has lead to islands within islands, and in turn to interesting "microbiogeography" questions.

A brief discussion on the use of cladistic techniques by Funk (Ch. 3) sets the stage for the specific studies of island biogeography that follow. Since determination of phylogeny is intrinsic to determination of species biogeography, this review of cladistic methods will help those unfamiliar with the terms and concepts. The chapters addressing specific taxonomic groups are fairly evenly divided between the islands fauna (Ch. 4-9) and its flora (Ch. 10-16). The genera of flowering plants that have been treated largely consist of species with a clearly defined taxonomy and are by all accounts monophyletic in origin. Although there are numerous other examples

that could just as easily have been selected, these represent research efforts that have been ongoing, and the information pertaining to biogeography is only a small portion of the work within that group [i.e., species of *Schiedea* (Ch. 21), the Silversword Alliance (Ch. 13), and Lobelioids (Ch. 14 & 15)].

The concluding chapter (Ch. 17) by Funk and Wagner summarizes the enormous amount of data presented, and condenses this work into five distinct patterns of distribution. Interestingly, only two genera of the 21 taxa analyzed by the various contributors presented a biogeography with an unresolved distribution pattern, and these two may be later resolved by more complete data on population dynamics of the species.

Two important conclusions should be drawn from this work. First, the critical need for obtaining more information on the species must be done soon while species are still available for study. Nearly one-half of the approximately 1200 species of flowering plants and ferns native to the Hawaiian Islands are listed as threatened, endangered or species of concern (Morden et al 1996). All of the plant genera examined in this book contain listed endangered or threatened species; for some (*Hibiscadelphus* and *Kokia*) the entire genus is endangered.

The second conclusion is that this work should only be considered an update of research in progress. A better understanding of population genetics, gene flow, and species evolution among these groups is sure to enhance our understanding of evolutionary processes and biogeography. Since the publication of this book there have already been significant discoveries that have altered our view of long-established "dogma" of Hawaiian biogeography (Givnish et al. 1996; Howarth and Morden, unpublished data). Future research will only continue to do so.

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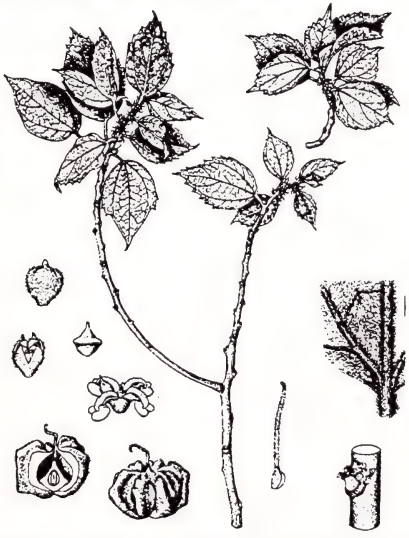

***Neraudia angulata* Cowan var. *dentata* Cowan**

Endangered, Threatened, Candidate Taxa and "Species of Concern" in the Hawaiian and Pacific Islands

Editors Note: The following list, compiled by the US Fish and Wildlife Service, Honolulu Office, contains the endangered (E), threatened (T), and candidate (C) taxa, as well as those "species of concern" (SOC) found in the Hawaiian and Pacific Islands. Species of concern are those taxa whose population numbers have been observed to be in decline in recent years. Some of these are also thought to be now extinct, but are listed until further field studies can confirm this. Lists complete with information containing island distributions, numbers of populations and species, and existing threats to the species may be obtained from the USF&W Honolulu Office (check with Marie Bruegmann or Christa Russell at 808-541-3441). Distribution data and species descriptions for many of the species is also available in Imada et al. (1989) or Wagner et al. (1989).

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Pteridophyta

Aspleniaceae

Asplenium fragile var. *insulare*	P
Asplenium schizophyllum	SOC
Deparia kaalaana	SOC
Diellia erecta	E
Diellia falcata	E
Diellia leucostegioides	SOC
Diellia mannii	SOC
Diellia pallida	P
Diellia unisora	P

Dennstaedtiaceae

Microlepia mauiensis	SOC

Dryopteridaceae

Ctenitis squamigera	E
Cystopteris douglasii	SOC
Diplazium molokaiense	P
Doryopteris takeuchii	SOC
Dryopteris podosora	SOC
Dryopteris tenebrosa	SOC
Dryopteris tetrapinnata	SOC

Grammitidaceae

Adenophorus periens	E

Isoetaceae

Isoetes hawaiiensis	SOC

Lindsaeaceae

Lindsaea repens var. *macraeana*	SOC

Lycopodiaceae

Lycopodium manii	E
Lycopodium nutans	E
Lycopodium phlegmaria var. *longifolium*	SOC

Marsiliaceae

Marsilea villosa	E

Ophioglossaceae

Botrychium subbifoliatum	SOC

Polypodiaceae

Microsorum spectrum	SOC

Pteridaceae

Pteris lidgatei	E

Thelypteridaceae

Thelypteris boydiae	SOC
Thelypteris wailele	SOC
Thylypteris warburgii	SOC

Magnoliophyta - Liliopsida (monocots)

Agavaceae

Pleomele fernaldii	SOC
Pleomele forbesii	SOC
Pleomele hawaiiensis	E

Cyperaceae

Carex wahuensis ssp. *herbstii*	SOC

Cyperus trachysanthos E
Fimbristylis hawaiiensis SOC
Gahnia lanaiensis E
Mariscus fauriei E
Mariscus kunthianus SOC
Mariscus pennatiformis
ssp. *bryanii* E
ssp. *pennatiformis* E
Mariscus rockii SOC
Torulinium odoratum
ssp. *auriculatum* SOC

Joinvilleaceae
Joinvillea ascendens
ssp. *ascendens* SOC

Liliaceae
Astelia waialealae C

Orchidaceae
Coelogyne guamensis SOC
Habenaria monogyne SOC
Nervilia jacksoniae SOC
Platanthera holochila E

Poaceae
Calamagrostis expansa SOC
Calamagrostis hillebrandii SOC
Cenchrus agrimonioides
var. *agrimonioides* E
var. *laysanensis* E
Dissochondrus biflorus SOC
Eragrostis deflexa SOC
Eragrostis fosbergii E
Eragrostis hosakai SOC
Eragrostis mauiensis SOC
Festuca hawaiiensis SOC
Ischaemum byrone E
Panicum fauriei
var. *carteri* E
Panicum niihauense E
Panicum ramosius SOC
Poa mannii E
Poa sandvicensis E
Poa siphonoglossa E

Magnoliophyta - Magnoliopsida (dicots)

Amaranthaceae
Achyranthes atollensis SOC
Achyranthes mutica E
Achyranthes splendens
var. *rotundata* E
Amaranthus brownii E
Charpentiera densiflora SOC
Nototrichium divaricatum SOC
Nototrichium humile E

Apiaceae
Peucedanum sandwicense T
Sanicula kauaiensis SOC
Sanicula mariversa E
Sanicula purpurea E
Sanicula sandwicensis SOC
Spermolepis hawaiiensis E

Apocynaceae
Ochrosia haleakalae SOC
Ochrosia kauaiensis SOC
Ochrosia kilaueaensis P
Pteralyxia kauaiensis E
Pteralyxia macrocarpa SOC

Araceae
Pritchardia affinis E
Pritchardia aylmer-robinsonii E
Pritchardia glabrata SOC
Pritchardia hardyi SOC
Pritchardia kaalae E
Pritchardia lanigera SOC
Pritchardia munroi E
Pritchardia napaliensis E
Pritchardia remota E
Pritchardia schattaueri E
Pritchardia viscosa E

Araliaceae
Munroidendron racemosum E
Osmoxylon mariannense C
Tetraplasandra gymnocarpa E
Tetraplasandra kavaiensis SOC
Tetraplasandra oahuensis SOC

Asteraceae
Argyroxiphium kauense E
Argyroxiphium sandwicense
ssp. *macrocephalum* T
ssp. *sandwicense* E
Argyroxiphium virescens
Bidens amplectens SOC
Bidens campylotheca
ssp. *campylotheca* SOC
ssp. *pentamera* SOC
ssp. *waihoiensis* SOC
Bidens conjuncta SOC
Bidens hawaiensis SOC
Bidens hillebrandiana
ssp. *hillebrandiana* SOC
Bidens mauiensis SOC
Bidens micrantha
ssp. *ctenophylla* C
ssp. *kalealaha* E
Bidens molokaiensis SOC
Bidens populilolia SOC
Bidens sandvicensis
ssp. *confusa* SOC
Bidens vallda
ssp. nov. SOC
Bidens wiebkei E
Dubautia arborea SOC
Dubautia herbstobatae E
Dubautia imbricata
ssp. *acronaea* SOC
ssp. *imbricata* SOC
Dubautia knudsenii
ssp. *filiformis* SOC
Dubautia latifolia E
Dubautia microcephala SOC
Dubautia pauciflorula E
Dubautia plantaginea
ssp. *humilis* C
ssp. *magnifolia* SOC
Dubautia platyphylla SOC
Dubautia sherffiana SOC
Dubautia sp. nov. 1 SOC
Dubautia sp. nov. 2 SOC
Dubautia waialealae SOC
Gnaphalium sandwic.
var. *molokaiense* SOC
Hesperomannia arborescens E
Hesperomannia arbuscula E
Hesperomannia lydgatei E
Lagenifera erici SOC
Lagenifera helenae SOC
Lagenifera maviensis SOC
Lipochaeta bryanii SOC
Lipochaeta degeneri SOC
Lipochaeta fauriei E
Lipochaeta kamolensis E
Lipochaeta lobata
var. *leptophylla* E
Lipochaeta micrantha
var. *exigua* E
var. *micrantha* E
Lipochaeta ovata SOC
Lipochaeta perdita SOC
Lipochaeta remyi SOC
Lipochaeta tenuifolia E
Lipochaeta tenuis SOC
Lipochaeta venosa E
Lipochaeta waimeaensis E
Remya kauaiensis E
Remya mauiensis E
Remya montgomeryi E

Tetramolopium arenarium
ssp. *arenarium* E
ssp. *laxum* E
Tetramolopium capillare E
Tetramolopium consanguineum
ssp. *consanguineum* SOC
ssp. *leptophyllum.* SOC
Tetramolopium conyzoides SOC
Tetramolopium filiforme
var. *filiforme* E
var. *polyphyllum* E
Tetramolopium humile
var. *sublaeve* SOC
Tetramolopium lepidotum
ssp. *arbusculum* SOC
ssp. *lepidotum* E
Tetramolopium remyi E
Tetramolopium rockii
var. *calcisabulorum* T
var. *rockii* T
Tetramolopium sp. SOC
Tetramolopium sylvae SOC
Tetramolopium tenerrimum SOC
Wilkesia hobdyi E

Bigoniaceae
Hillebrandia sandwicensis SOC

Brassicaceae
Lepidium arbuscula E
Lepidium bidentatum
var. *o-waihiense* SOC
var. *remyi* SOC
Lepidium serra SOC

Campanulaceae
Brighamia insignis E
Brighamia rockii E
Clermontia calophylla SOC
Clermontia drepanomorpha E
Clermontia grandiflora
ssp. *maxima* SOC
Clermontia lindseyana E
Clermontia multiflora SOC
Clermontia oblongifolia
ssp. *brevipes* E
ssp. *mauiensis* E
Clermontia peleana
ssp. *peleana* E
ssp. *singulifolia* E
Clermontia persicifolia SOC
Clermontia pyrularia E
Clermontia samuelii
ssp. *hanaensis* SOC
ssp. *samuelii* SOC
Clermontia tuberculata SOC
Clermontia walmeae SOC
Cyanea acuminata E
Cyanea arborea SOC
Cyanea asarifolia E
Cyanea asplenifolia SOC
Cyanea comata SOC
Cyanea copelandii
ssp. *copelandii* E
ssp. *haleakalaensis* C
Cyanea crispa E
Cyanea dolichopoda SOC
Cyanea dunbarii E
Cyanea eleeleensis SOC
Cyanea gilfardii SOC
Cyanea glabra C
Cyanea grimesiana
ssp. *cylindrocalyx* SOC
ssp. *grimesiana* E
ssp. *obatae* E
Cyanea hamatiflora
ssp. *carlsonii* E
ssp. *hamatiflora* C
Cyanea horrida SOC
Cyanea humboldtiana E
Cyanea kolekoleensls SOC
Cyanea koolauensis E
Cyanea kunthiana SOC
Cyanea lanceolata
ssp. *calycina* SOC
ssp. *lanceolata* SOC
Cyanea leptostegia SOC
Cyanea linearifolia SOC
Cyanea lobata E
Cyanea longiflora E
Cyanea longissima SOC
Cyanea macrostegia
ssp. *gibsonii* E
Cyanea mannii E
Cyanea marksii SOC
Cyanea mceldownevi E
Cyanea membranacea SOC
Cyanea obtusa SOC
Cyanea parvifolia SOC
Cyanea pinnatifida E
Cyanea platyphylla E
Cyanea pohaku SOC
Cyanea procera E
Cyanea profuga SOC
Cyanea purpurellifolia SOC
Cyanea pycnocarpa SOC
Cyanea quercifolia SOC
Cyanea recta T
Cyanea remyi E
Cyanea shipmanii E
Cyanea solanacea SOC
Cyanea solenocalyx SOC
Cyanea sp. loc. Kauai SOC
Cyanea st.-johnii E
Cyanea stictophylla E
Cyanea superba
ssp. *regina* E
ssp. *superba* E
Cyanea tritomantha SOC
Cyanea truncata E
Cyanea undulata E
Delissea fallax SOC
Delissea laciniata SOC
Delissea lauliiana SOC
Delissea parviflora SOC
Delissea rhytidosperma E
Delissea rivularis E
Delissea sinuata
ssp. *lanaiensis* SOC
ssp. *sinuata* SOC
Delissea subcordata E
Delissea undulata
ssp. *kauaiensis* E
ssp. *niihauensis* E
ssp. *undulata* E
Lobelia dunbarii
ssp. *dunbarii* SOC
ssp. *paniculata* SOC
Lobelia gaudichaudii
ssp. *gaudichaudii* SOC
ssp. *koolauensis* E
Lobelia hypoleuca SOC
Lobelia monostachya E
Lobelia niihauensis E
Lobelia oahuensis E
Lobelia remyi SOC
Lobelia yuccoides SOC
Trematolobelia grandifolia SOC
Trematolobelia singularis E

Capparidaceae
Cleome spinosa
ssp. nov. SOC
Capparis sandwichiana SOC

Caryophyllaceae
Alsinidendron obovatum E
Alsinidendron trinerve E
Alsinidendron viscosum E
Alsinidendron lychnoides E
Schiedea adamantis E
Schiedea amplexicaulis SOC
Schiedea apokremnos E
Schiedea attenuata SOC
Schiedea diffusa SOC

Schiedea haleakalensis E
Schiedea helleri E
Schiedea hookeri E
Schiedea implexa SOC
Schiedea lydgatei E
Schiedea kaalae E
Schiedea kauaiensis E
Schiedea kealiae E
Schiedea ligustrina SOC
Schiedea mannii SOC
Schiedea membranacea E
Schiedea menziesii SOC
Schiedea nuttallii E
Schiedea pubescens
var. *pubescens* SOC
var. *purpurascens* SOC
Schiedea salicaria SOC
Schiedea sarmentosa E
Schiedea sp. SOC
Schiedea spergulina
var. *leiopoda* E
var. *spergulina* T
Schiedea stellarioides E
Schiedea verticillata E
Silene alexandri E
Silene cryptopetala SOC
Silene degeneri SOC
Silene hawaiiensis T
Silene lanceolata E
Silene perlmanii E

Convolvulaceae
Bonamia menziesii E

Cucurbitaceae
Sicyos alba E
Sicyos cucumerinus SOC
Sicyos hillebrandii SOC
Sicyos macrophyllus SOC
Sicyos sp. A SOC
Sicyos waimanaloensis SOC

Euphorbiaceae
Chamaesyce arnottiana SOC
Chamaesyce atrococca SOC
Chamaesyce celastroides
var. *kaenana* E
var. *laehiensis* SOC
var. *tomentella* SOC
Chamaesyce clusiifolia SOC
Chamaesyce deppeana E
Chamaesyce eleanoriae SOC
Chamaesyce halemanui E
Chamaesyce herbstii E
Chamaesyce kuwaleana E
Chamaesyce olowaluana SOC
Chamaesyce remyi
var. *hanaleiensis* SOC
var. *kauaiensis* SOC
var. *remyi* SOC
Chamaesyce rockii E
Chamaesyce skottsbergii
var. *skottsbergii* E
var. *vaccinioides* SOC
Chamaesyce sparsiflora SOC
Euphorbia haeleeleana
Flueggea neowawraea E

Fabaceae
Acacia koaia SOC
Caesalpinia kavaiensis E
Canavalia molokaiensis E
Canavalia napaliensis SOC
Canavalia pubescens SOC
Kanaloa kohoolawensis C
Mucuna sloanei
var. *persericea* SOC
Serianthes nelsonii E
Sesbania tomentosa E
Strongylodon ruber SOC
Tabernaemontana rotensis C
Vicia menziesii E
Vigna o-wahuensis E

Flacourtiaceae
Xylosma crenatum E

Gentianaceae
Centaurium sebaeoides E

Geraniaceae
Geranium arboreum E
Geranium hanaense SOC
Geranium humile SOC
Geranium kauaiense SOC
Geranium multiflorum E

Gesneriaceae
Cyrtandra biserrata SOC
Cyrtandra crenata E
Cyrtandra cyaneoides E
Cyrtandra dentata E
Cyrtandra filipes SOC
Cyrtandra giffardii E
Cyrtandra gracilis SOC
Cyrtandra halawensis SOC
Cyrtandra hematos SOC

Cyrtandra kamoloensis SOC
Cyrtandra kaulantha SOC
Cyrtandra kealiae SOC
Cyrtandra kohalae SOC
Cyrtandra limahuliensis T
Cyrtandra lydgatei SOC
Cyrtandra macrocalyx SOC
Cyrtandra menziesii SOC
Cyrtandra munroi E
Cyrtandra oenobarba SOC
Cyrtandra olona SOC
Cyrtandra oxybapha SOC
Cyrtandra pickeringii SOC
Cyrtandra polyantha E
Cyrtandra pruinosa SOC
Cyrtandra rivularis SOC
Cyrtandra sandwicensis SOC
Cyrtandra sessilis SOC
Cyrtandra subumbellata E
Cyrtandra tintinnabula E
Cyrtandra viridiflora E
Cyrtandra waiolani SOC

Goodeniaceae
Scaevola coriacea E
Scaevola kilaueae SOC

Lamiaceae
Haplostachys bryanii SOC
Haplostachys haplostachya E
Haplostachys linearifolia SOC
Haplostachys munroi SOC
Haplostachys truncata SOC
Phyllostegia bracteata SOC
Phyllostegia brevidens SOC
Phyllostegia floribunda SOC
Phyllostegia glabra
var. *lanaiensis* E
Phyllostegia helleri SOC
Phyllostegia hillebrandii SOC
Phyllostegia hirsuta E
Phyllostegia hispida SOC
Phyllostegia imminuta SOC
Phyllostegia kaalaensis E
Phyllostegia knudsenii E
Phyllostegia mannii E
Phyllostegia mollis E
Phyllostegia parviflora
var. *glabriuscula* E
var. *lydgatei* E
var. *parviflora* E
Phyllostegia racemosa E
Phyllostegia rockii SOC
Phyllostegia stachyoides SOC
Phyllostegia variabilis SOC
Phyllostegia velutina E
Phyllostegia vestita SOC
Phyllostegia waimeae E

Phyllostegia warshaueri E
Phyllostegia wawrana E
Stenogyne angustifolia E
Stenogyne bifida E
Stenogyne campanulata E
Stenogyne cinerea SOC
Stenogyne cranwelliae SOC
Stenogyne haliakalae SOC
Stenogyne kanehoana E
Stenogyne kealiae SOC
Stenogyne macrantha SOC
Stenogyne oxygona SOC
Stenogyne scrophularioides SOC
Stenogyne viridis SOC
Streblus pendulinus SOC

Lauraceae
Litsea samoensis SOC

Loganaiceae
Labordia lydgatei E
Labordia cyrtandrae E
Labordia helleri SOC
Labordia hosakana SOC
Labordia kaalae SOC
Labordia pumila SOC
Labordia tinifolia
var. *lanaiensis* SOC
var. *wahiawaensis* E
Labordia triflora C

Malvaceae
Abutilon eremitopetalum E
Abutilon menziesii E
Abutilon sandwicense E
Hibiscadelphus bombycinus SOC
Hibiscadelphus crucibracteatus SOC
Hibiscadelphus distans E
Hibiscadelphus giffardianus E
Hibiscadelphus hualalaiensis E
Hibiscadelphus wilderianus SOC
Hibiscadelphus woodii E
Hibiscus arnottianus
ssp. *immaculatus* E
Hibiscus brackenridgei
ssp. *brackenridgei* E
ssp. *mokuleianus* E
Hibiscus clayi E
Hibiscus kokio
ssp. *kokio* SOC
ssp. *saintjohnianus* SOC
Hibiscus waimeae
ssp. *hannerae* E
Kokia cookei E
Kokia drynarioides E
Kokia kauaiensis E
Kokia lanceolata SOC

Minispermaceae
Tinosperma homosepala SOC

Myrsinaceae
Embelia pacifica SOC
Myrsine fosbergii SOC
Myrsine juddii E
Myrsine knudsenii SOC
Myrsine linearifolia T
Myrsine mezii SOC
Myrsine vaccinioides SOC

Myrtaceae
Eugenia koolauensis E

Nesogenaceae
Nesogenes rotensis C

Nyctaginaceae
Pisonia wagneriana SOC

Phytolaccaceae
Phytolacca sandwicensis SOC

Piperaceae
Peperomia degeneri SOC
Peperomia rockii SOC

Pittosporaceae
Pittosporum argentifolium SOC
Pittosporum napaliense SOC

Plantaginaceae
Plantago hawaiensis E
Plantago princeps
var. *anomala* E
var. *laxiflora* E
var. *longibracteata* E
var. *princeps* E

Portulacaceae
Portulaca molokiniensis SOC
Portulaca sclerocarpa E
Portulaca villosa SOC

Primulaceae
Lysimachia daphnoides SOC
Lysimachia filifolia E
Lysimachia forbsii SOC
Lysimachia kalalauensis SOC
Lysimachia lydgatei E
Lysimachia maxima E
Lysimachia sp. nov. 1 SOC
Lysimachia sp. nov. 2 SOC
Lysimachia venosa SOC

Ranunculaceae
Ranunculus hawaiensis SOC
Ranunculus mauiensis SOC

Rhamnaceae
Colubrina oppositifolia E
Gouania hillebrandii E
Gouania meyenii E
Gouania vitifolia E

Rosaceae
Acaena exigua E
Rubus macraei SOC

Rubiaceae
Bobea timonioides SOC
Gardenia brighamii E
Gardenia mannii E
Gardenia remyi SOC
Hedyotis cookiana E
Hedyotis coriacea E
Hedyotis degeneri
var. *coprosmifolia* E
var. *degeneri* E
Hedyotis elatior SOC
Hedyotis fluviatilis SOC
Hedyotis foliosa SOC
Hedyotis formosa SOC
Hedyotis littoralis SOC
Hedyotis mannii E
Hedyotis parvula E
Hedyotis schlechtendahliana
var. *remyi* C
Hedyotis sp. SOC
Hedyotis st.-johnii E
Hedyotis tryblium SOC
Morinda trimera SOC
Psychotria grandiflora SOC
Psychotria hexandra
ssp. *oahuensis* SOC
Psychotria hobdyi SOC

Rutaceae
Acronychia retusa SOC
Melicope adscendens E
Melicope balloui E
Melicope christophersenii SOC
Melicope cruciata SOC
Melicope degeneri SOC
Melicope haleakalae SOC
Melicope haupuensis E

Melicope hawaiensis	SOC
Melicope hiiakae	SOC
Melicope knudsenii	E
Melicope lydgatei	E
Melicope macropus	SOC
Melicope makahae	SOC
Melicope mucronulata	E
Melicope munroi	C
Melicope nealae	SOC
Melicope obovata	SOC
Melicope ovalis	E
Melicope pallida	E
Melicope paniculata	SOC
Melicope puberula	SOC
Melicope quadrangularis	E
Melicope reflexa	E
Melicope saint-johnii	E
Melicope wailauensis	SOC
Melicope zahlbruckneri	E
Platydesma cornuta	
var. *cornuta*	SOC
var. *decurrens*	SOC
Platydesma remyi	SOC
Platydesma rostrata	SOC
Zanthoxylum dipetalum	
var. *dipetalum*	SOC
var. *tomentosum*	E
Zanthoxylum hawaiiense	E
Zanthoxylum oahuense	SOC

Santalaceae

Exocarpos gaudichaudii	SOC
Exocarpos luteolus	E
Santalum freycinetianum	
var. *lanaiense*	E

Sapindaceae

Alectryon macrococcus	
var. *auwahiensis*	E
var. *macrococcus*	E
var. nov.	SOC

Sapotaceae

Manikara dissecta	SOC
Nesoluma polynesicum	SOC

Solanaceae

Nothocestrum breviflorum	E
Nothocestrum latifolium	SOC
Nothocestrum peltatum	E
Solanum incompletum	E
Solanum nelsonii	SOC
Solanum sandwicense	E

Theaceae

Eurya sandwicensis	SOC

Thymelacaceae

Wikstroemia bicornuta	SOC
Wikstroemia hanalei	SOC
Wikstroemia skottsbergiana	SOC
Wikstroemia villosa	SOC

Urticaceae

Elatostema tutilense	SOC
Neraudia angulata	
var. *angulata*	E
var. *dentata*	E
Neraudia kauaiensis	SOC
Neraudia melastomifolia	SOC
Neraudia ovata	E
Neraudia sericea	E
Urera kaalae	E

Violaceae

Isodendrion hosakae	E
Isodendrion laurifolium	E
Isodendrion longifolium	T
Isodendrion pyrifolium	E
Viola chamissoniana	
ssp. *chamissoniana*	E
Viola helenae	E
Viola kauaensis	
var. *wahiawaensis*	E
Viola lanaiensis	E
Viola oahuensis	E

Viscaceae

Korthalsella degeneri	SOC

Kokio cookei Degener
Extinct in the Wild

News and Announcements

If you have news or announcements that you think would be of interest to the Society members, please submit them for inclusion in later issues of this newsletter. Submissions can be made care of: Clifford W. Morden, Newsletter Editor, Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, HI 96822 or via e-mail at cmorden@hawaii.edu.

Web Sites

There are a number of world-wide websites that may be of interest to browse through. Some are of general interest in systematics, others specific for our Hawaiian flora.

Tree of Life Project

The Tree of Life Project has formally opened its site to the public. This is a collection of web pages assembled by over 120 contributors around the world and contains information about many groups of organisms (phylogenies, introduction, characteristics, discussions of phylogenetic relationships, references, etc.). The eventual goal is to have this Tree complete to the species level in many different groups of organisms. View this site at:

http://phylogeny.arizona.edu/tree/phylogeny.html

SOS Hawaiian Plants

Pricilla Millen has now got the "SOS Hawaiian Flora" website on-line. For additional information about SOS Hawaii, contact Pricilla at pmillen@hawaii.edu. View this site at:

http://alaike.lcc.hawaii.edu/sos/sos_home.html

Monitoring Invasive Plants and Feral Ungulates

There is now a database being collected and made available on non-native invasive plants and the effects of feral ungulates. View this site at:

http://www2.hawaii.edu/~halesci/
MiconiaInHawaiiMonitoringDatabase
(the last part is all one word!)

Other Web Sites

Other sites published in the Plant Science Bulletin recently that may be of general botanical interest are listed here. Someone may want to check them out and let us know what they have to offer.

http://meena.cc.uregina.ca/~liushus/bio/botany.html

http://biomserv.univ-lyonl.fr/Ecology-WWW.html

http://www.orst.edu/Edpt/botany/herbarium/coolstuff/Brach_list.html

http://www.uwm.edu/Dept/Biology/Docs/botany.html

Flora of China: http://straylight.tamu.edu/MoBot/FC/fch_intr.html

Community Action

At a recent Botanical Society Meeting Reese Liggett of the Sierra Club announced that a community action group has been formed in Haleiwa to address issues (off-road vehicles, dirt bikes, etc.) surrounding conservation of Ka'ena Point. Views and comments can be expressed at a monthly meeting at the Ali'i Park Surf Center, Haleiwa, 7 pm, the evening of the first Tuesday of every month.

Hikes

There is a monthly hike planned for the members of the Hawaiian Botanical Society. Call or e-mail Aaron Lowe for more information at 973-9782 or alowe@hgea.org.

Minutes of the Hawaiian Botanical Society

September Meeting

• The September 9th meeting of the Hawaiian Botanical Society was called to order by Wisteria Loeffler, President. The minutes from the May meeting were approved as read.

• **Guests.** Guests introduced were Carol Annable of the New York Botanical Garden and Curtis Daehler of the University of Hawai'i Department of Botany.

• **Treasurers Report.** Ron Fenstemacher, Treasurer, reported a balance of $2968 in the bank.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, reported a total of 167 members with 4 new members approved. Alvin noted the passing of two members, Max Doty of the Department of Botany and Walter Appleby of the Bishop Museum. Pat Conant volunteered to assist Alvin with the mailing of meeting announcements.

• **New Business.** Several items of new business were discussed:

- The President announced the availability to members of a discounted software package for landscape use of native plants.
- The Newsletter Editor, Greg Koob, resigned to pursue other interests. Cliff Morden volunteered to fill this position.
- After some discussion, a motion was made by Don Gowing for the Botanical Society to sponsor a student research scholarship, asking the Marie Neal Fund to supply the needed funds. The motion was seconded by Gary Ray.
- No hike will take place for the month of September but the monthly hikes will resume in October.
- The Pōhakaloa Training Area asked the Botanical Society for a member to attend meetings on the Big Island to discuss the management of the area. Susan Cordell has been attending the meetings and will relate the information she has collected when the meetings conclude.
- Pat Conant announced the progress of *Miconia* eradication is going well and asked for volunteers to help.

• **The Plant of the Month**, given by Tim Motley, was titled "Pollen Pigs in Hawaiian Native Flora".

• **Guest Speaker**, Gary Ray, presented the Status and an Update of Hawaiian Plants at the Center for Plant Conservation (CPC).

October Meeting

• The October 7 meeting of the Hawaiian Botanical Society was called to order by James Kwon, Vice-President. The minutes from the September meeting were approved as read.

• **Treasurers Report.** Ron Fenstamacher, treasurer, reported a balance of $2564 in out account, plus $2540 in a certificate of deposit.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, proposed five new members, bringing the society's members to 185.

• **New Business**

- Schloarship Committee business was updated by Priscilla Millen. A motion was passed to ask the Marie Neal Fund for $700 for a scholarship to be sponsored by the Botanical Society, $200 of which was to be used by the committee for publicity and incidental expenses and $500 for the scholarship award.
- Announcements were made for a native plant sale at Leeward Community College, the creation of SOS Hawaiian Plants web site, and a *Miconia* search and destroy hike at Aihualama sponsored by Sierra Club.

- Steve Montgomery announced an article in the Smithsonian magazine on Hawai'i, emphasizing *Hibiscadelphus* and also asked the membership to watch for candidate recommendations made by the Hawai'i Coalition of Conservation Voters.

- Phillip Thomas of the Research Corporation of University of Hawai'i announced web sites for information on *Miconia* and a monitoring database for the envasion of non-natives in Hawai'i and the effects of feral ungulates.

- Another announcement was made on behalf of the Hawaiian Audobon Society stating that results of plant or animal research could be published in their journal.

- **The Plant of the Month** speaker was ill, and an impromptu talk was given by Alvin Yoshinaga about Edelweiss.

- **Guest Speaker** for October was Art Mederios of Haleakalā National Park, on Conservation and Restoration in Kupahulu and Kahikinui, Maui.

November Meeting

- The November 4 meeting of the Hawaiian Botanical Society was called to order by Wisteria Loeffler, President. The minutes were approved as read.

- **Treasurers Report.** Ron Fenstamacher, Treasurer, gave the treasurer's report.

- **Membership Report.** Alvin Yoshinaga, Membership Chair, reported one new member, bringing the total membership to 189.

- **Scholarship Committee Report.** Priscilla Millen, Scholarship Committee Chair, reported that letters will be sent in November, announcing the scholarship for 1997.

- **New Officers.** The nominating committee for officers for the Botanical Society announced the following candidates for office:

  - President: Wisteria Loeffler
  - Vice-President: Curtis Daeyler
  - Secretary: Vickie Caraway
  - Treasurer: Ron Fenstamacher

These candidates and other nominations from the floor will taken to a vote in the December membership meeting.

- New Business

  - The President asked for volunteers to join James Kwon and Winona Char in judging the Science Fair in 1997.

  - The President also asked the membership for comments on recovery plans for different area preserves.

  - The availability of pamphlets for Mānoa Cliffs trail was announced. One of the pamphlets will be available at the head of the upper Mānoa Cliffs trail.

  - The UH Department of Geography announced three seminars on habitats to be given in November.

  - The November field trip will be to the Ka'ala Road *kauila* tree site on Saturday November 23.

- **The Plant of the Month** talk was given by Ginny Mead of the University of Hawai'i Department of Horticulture on *'ie'ie* (*Freycinettia arborea*)

- **Guest Speaker** for November was Carol Annable of the New York Botanical Gardens on Bioprospecting.

Inside Next Issue
Volume 36 (1)

- *Conservation strategies for extremely bottlenecked species.* By C. W. Morden
- *Hawaiian* Pritchardia *Palms: Seed predation and the distribution of adults and seedlings.* W. Loeffler and T. Male
- *Status of Marsilea villosa populations at the Ihe'ihelauakea Crater, O'ahu.* By M. Wilkinson
- Vegetation in the back of Mānoa Valley, O'ahu, is largely non-native: Things ain't what they used to be. By L. Hasty and J. Zamzow

Do you have something you would like to contribute to the *Newsletter*? All contributions are welcome. They may be technical articles related to on-going research, comments about current events, or field observations you may have made from a recent expedition.

Contributions may be sent to the *Newsletter* Editor via manuscript, disc (please provide hard-copy also), or E-mail at:

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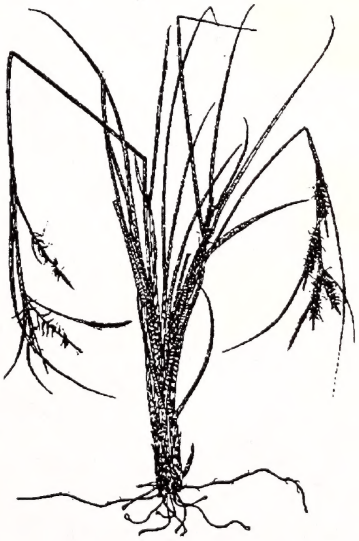

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SLETTER OF THE HAWAIIAN BOTANICAL SOCIETY
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